17253 - Imaging and Spectroscopy of Three Highly Magnified Images of a Supernova at z=1.5

Cycle: 29, Proposal Category: GO/DD

(Availability Mode: SUPPORTED)

INVESTIGATORS

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VISITS

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
01	(1) LENSED-SN-1	WFC3/IR	1	18-Oct-2022 18:00:20.0	yes
02	(1) LENSED-SN-1	WFC3/IR	2	18-Oct-2022 18:00:22.0	yes

3 Total Orbits Used

ABSTRACT

We have detected a strongly lensed supernova (SN) in HST imaging of the RX J2129 galaxy-cluster field acquired on August 7, 2022. The SN's apparent F110W magnitude of 24.70+-0.15 and a non-detection in F606W yield an 80% probability that the transient is a Type Ia SN. The foreground galaxy-cluster gravitational lens creates a set of three images of the SN's host galaxy at redshift 1.52, and we have detected the SN in the trailing, or last-arriving image. The other images are predicted to have arrived ~320 and ~1000 days previously.

A target-of-opportunity program with HST has been triggered to measure the transient's light curve through late October. Here we propose three single-orbit WFC3 IR F110W/F160W visits followed by a two-orbit visit to measure the SN's light curve through late December. In a joint proposal, we request NIRSpec G140M and PRISM spectroscopy at the locations of all three images in early October, when the field becomes accessible to JWST. If the SN is a Type Ia SN, then we will be able to calibrate its luminosity and directly measure its magnification. This will provide a novel test of galaxy-cluster mass models. The spectra will enable comparision with low-redshift SNe Ia to address an important systematic that may affect SN Ia cosmology.

We also propose for deep JWST NIRCam imaging to measure the flux of the previous arrival of the SN. With 5-sigma limiting depth of 29.2, imaging in F150W can be expected to detect the fading image. Its brightness will constrain the SN's age, and therefore the image's relative time delay. A strong detection and well-characterized SN Ia may enable a new, independent measurement of the Hubble constant.

OBSERVING DESCRIPTION

We will acquire F110W and F160W imaging in three visits following the final scheduled visit from GO-16264 (PI: Pierel). Each visit will be split between F110W and F160 WFC3 IR imaging acquired with a dither pattern. The F160W imaging is scheduled for the beginning and end of the visit to minimize Zodaical light contamination of the F110W.

The field has visibility through December 23rd, 2022.

Visit 18 of GO-16264 is scheduled for Oct 31, 2022 - Nov 10, 2022, and there are two remaining visits scheduled to follow by 10-14 days. Therefore, GO-16264 should be able to acquire observations the week of Nov 11 - 21 and then Nov 22 - Dec 1.

Therefore, we hope to schedule visit 1, 2, and 3 for Dec 1 - Dec 8, Dec 9-Dec 17, and then Dec 18-23.

Visit

Proposal 17253, WFC3 F110W/F160W (01), implementation Tue Oct 18 22:00:23 GMT 2022

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/IR

Special Requirements: SCHED 100%; BETWEEN 01-DEC-2022:00:00:00 AND 10-DEC-2022:00:00:00; TOO RESPONSE TIME 21.0D

Comments: 3 short WFC3-IR F110W and 3 short WFC3-IR F160W exposures of new source in RX-J2129 field.

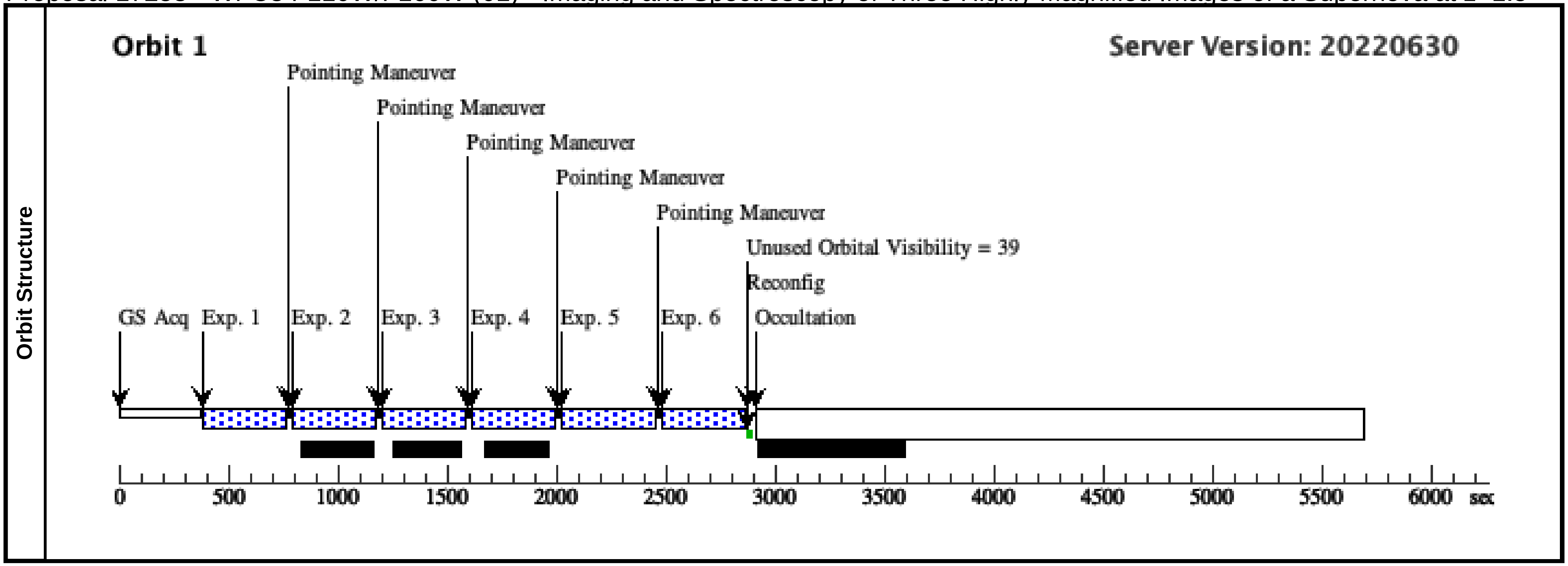
Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	LENSED-SN-1	RA: 21 29 40.1969 (322.4174871d) Dec: +00 05 24.62 (.09017d) Equinox: J2000		V=25+/-0.5	Reference Frame: ICRS

Comments:
Category=EXT-STAR
Description=[SUPERNOVA]

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	F160W	(1) LENSED-SN-1	WFC3/IR, MULTIACCUM, IR	F160W	NSAMP=12; SAMP-SEQ=STEP50	POS TARG 0,0	Sequence 1-6 Non-Int in WFC3 F110W/F160W (01)	349.232932 Secs (349.233 Secs) *[==>]*	***[1]***
2	F160W	(1) LENSED-SN-1	WFC3/IR, MULTIACCUM, IR	F160W	NSAMP=12; SAMP-SEQ=STEP50	POS TARG 0.451,0.403	Sequence 1-6 Non-Int in WFC3 F110W/F160W (01)	349.232932 Secs (349.233 Secs) *[==>]*	***[1]***
3	F110W	(1) LENSED-SN-1	WFC3/IR, MULTIACCUM, IR	F110W	NSAMP=12; SAMP-SEQ=STEP50	POS TARG .474,.424	Sequence 1-6 Non-Int in WFC3 F110W/F160W (01)	349.232932 Secs (349.233 Secs) *[==>]*	***[1]***
4	F110W	(1) LENSED-SN-1	WFC3/IR, MULTIACCUM, IR	F110W	NSAMP=12; SAMP-SEQ=STEP50	POS TARG .925,.827	Sequence 1-6 Non-Int in WFC3 F110W/F160W (01)	349.232932 Secs (349.233 Secs) *[==>]*	***[1]***
5	F110W	(1) LENSED-SN-1	WFC3/IR, MULTIACCUM, IR	F110W	NSAMP=13; SAMP-SEQ=STEP50	POS TARG 1.376,1.230	Sequence 1-6 Non-Int in WFC3 F110W/F160W (01)	399.233383 Secs (399.233 Secs) *[==>]*	***[1]***
6	F160W	(1) LENSED-SN-1	WFC3/IR, MULTIACCUM, IR	F160W	NSAMP=12; SAMP-SEQ=STEP50	POS TARG 0.902,0.806	Sequence 1-6 Non-Int in WFC3 F110W/F160W (01)	349.232932 Secs (349.233 Secs) *[==>]*	***[1]***


Orbit Structure
Orbit 1
Server Version: 20220630
Pointing Maneuver
Pointing Maneuver
Pointing Maneuver
Pointing Maneuver
Pointing Maneuver
Unused Orbital Visibility = 39
Reconfig
GS Acq
Exp. 1
Exp. 2
Exp. 3
Exp. 4
Exp. 5
Exp. 6
Occultation
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
sec

Visit

Proposal 17253, WFC3 F110W/F160W (02), implementation Tue Oct 18 22:00:23 GMT 2022

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/IR

Special Requirements: SCHED 100%; AFTER 01 BY 10 D TO 16 D; BEFORE 25-DEC-2022:00:00:00; TOO RESPONSE TIME 21.0D

Comments: 3 short WFC3-IR F110W and 3 short WFC3-IR F160W exposures of new source in RX-J2129 field.

Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	LENSED-SN-1	RA: 21 29 40.1969 (322.4174871d) Dec: +00 05 24.62 (.09017d) Equinox: J2000		V=25+/-0.5	Reference Frame: ICRS

Comments:
Category=EXT-STAR
Description=[SUPERNOVA]

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	F160W	(1) LENSED-SN-1	WFC3/IR, MULTIACCUM, IR	F160W	NSAMP=12; SAMP-SEQ=STEP50	POS TARG 0,0	Sequence 1-6 Non-Int in WFC3 F110W/F160W (02)	349.232932 Secs (349.233 Secs) [==>]	[1]
2	F160W	(1) LENSED-SN-1	WFC3/IR, MULTIACCUM, IR	F160W	NSAMP=12; SAMP-SEQ=STEP50	POS TARG 0.451,0.403	Sequence 1-6 Non-Int in WFC3 F110W/F160W (02)	349.232932 Secs (349.233 Secs) [==>]	[1]
3	F110W	(1) LENSED-SN-1	WFC3/IR, MULTIACCUM, IR	F110W	NSAMP=12; SAMP-SEQ=STEP50	POS TARG .474,.424	Sequence 1-6 Non-Int in WFC3 F110W/F160W (02)	349.232932 Secs (349.233 Secs) [==>]	[1]
4	F110W	(1) LENSED-SN-1	WFC3/IR, MULTIACCUM, IR	F110W	NSAMP=12; SAMP-SEQ=STEP50	POS TARG .925,.827	Sequence 1-6 Non-Int in WFC3 F110W/F160W (02)	349.232932 Secs (349.233 Secs) [==>]	[1]
5	F110W	(1) LENSED-SN-1	WFC3/IR, MULTIACCUM, IR	F110W	NSAMP=13; SAMP-SEQ=STEP50	POS TARG 1.376,1.230	Sequence 1-6 Non-Int in WFC3 F110W/F160W (02)	399.233383 Secs (399.233 Secs) [==>]	[1]
6	F160W	(1) LENSED-SN-1	WFC3/IR, MULTIACCUM, IR	F160W	NSAMP=12; SAMP-SEQ=STEP50	POS TARG 0.902,0.806	Sequence 1-6 Non-Int in WFC3 F110W/F160W (02)	349.232932 Secs (349.233 Secs) [==>]	[1]
7	F160W	(1) LENSED-SN-1	WFC3/IR, MULTIACCUM, IR	F160W	NSAMP=12; SAMP-SEQ=STEP50	POS TARG 0.333,0.333	Sequence 7-12 Non-Int in WFC3 F110W/F160W (02)	349.232932 Secs (349.233 Secs) [==>]	[2]
8	F160W	(1) LENSED-SN-1	WFC3/IR, MULTIACCUM, IR	F160W	NSAMP=12; SAMP-SEQ=STEP50	POS TARG 0.784,0.736	Sequence 7-12 Non-Int in WFC3 F110W/F160W (02)	349.232932 Secs (349.233 Secs) [==>]	[2]
9	F110W	(1) LENSED-SN-1	WFC3/IR, MULTIACCUM, IR	F110W	NSAMP=12; SAMP-SEQ=STEP50	POS TARG .8069,.757	Sequence 7-12 Non-Int in WFC3 F110W/F160W (02)	349.232932 Secs (349.233 Secs) [==>]	[2]
10	F110W	(1) LENSED-SN-1	WFC3/IR, MULTIACCUM, IR	F110W	NSAMP=12; SAMP-SEQ=STEP50	POS TARG 1.258,1.16	Sequence 7-12 Non-Int in WFC3 F110W/F160W (02)	349.232932 Secs (349.233 Secs) [==>]	[2]
11	F110W	(1) LENSED-SN-1	WFC3/IR, MULTIACCUM, IR	F110W	NSAMP=13; SAMP-SEQ=STEP50	POS TARG 1.70899,1.563	Sequence 7-12 Non-Int in WFC3 F110W/F160W (02)	399.233383 Secs (399.233 Secs) [==>]	[2]
12	F160W	(1) LENSED-SN-1	WFC3/IR, MULTIACCUM, IR	F160W	NSAMP=12; SAMP-SEQ=STEP50	POS TARG 1.235,1.139	Sequence 7-12 Non-Int in WFC3 F110W/F160W (02)	349.232932 Secs (349.233 Secs) [==>]	[2]

Orbit Structure